

What is claimed is:

1           1. A Voice over Internet Protocol (VoIP) network comprising:  
2           an IP backbone;  
3           an application server providing content to the VoIP network;  
4           a network manager controlling components in the VoIP network; and,  
5           an access switch terminating an access device and connecting the access device to the IP  
6 backbone, wherein all session state associated with a call from the access device is maintained in  
7 the access switch.

1           2. The VoIP network of claim 1, wherein the IP backbone comprises an IP/Multi-  
2 Protocol Label Switching (MPLS) core.

1           3. The VoIP network of claim 2, wherein the access switch further comprises:  
2 a line interface card terminating the access device and defining a subscriber interface for  
3 the access device; and,  
4 a packet interface card connected to the IP backbone via a high bandwidth IP/MPLS  
5 backplane.

1           4. The VoIP network of claim 3, wherein the line interface card and packet interface card  
2 are connected via the high bandwidth IP/MPLS backplane.

1           5. The VoIP network of claim 1, wherein the access device comprises one selected from  
2 a group consisting of: an individual access device, an integrated access device, and a trunking  
3 interface.

1           6. A Voice over Internet Protocol (VoIP) network communicating via Session Initiation  
2 Protocol (SIP) messages and being connected to a non-IP network, the VoIP network  
3 comprising:

4           an IP backbone;

5           an access switch terminating an access device and connecting the access device to the IP  
6 backbone, wherein all session state associated with a call from the access device is maintained in  
7 the access switch; and,

8           a signaling gateway connecting the VoIP network and the non-IP network, wherein only  
9 transaction state associated with the call is maintained in the signaling gateway.

1           7. The VoIP network of claim 6, wherein transaction state is maintained in the signaling  
2 gateway only during pendency of the related transaction.

1           8. The VoIP network of claim 7, wherein the non-IP network comprises a Signaling  
2 System Seven (SS7) network and the signaling gateway further comprises:

3           a SIP parser receiving SIP messages from the VoIP network;

4           a SS7 protocol stack receiving SS7 messages from the SS7 network;

5           a translator receiving/transmitting SIP messages from/to the SIP parser, and  
6 receiving/transmitting SS7 messages from/to the SS7 protocol stack, wherein the translator  
7 converts SIP messages from/to SS7 messages.

1           9. The VoIP network of claim 8, wherein the translator performs conversion of SIP and  
2 SS7 messages using direct mapping.

1           10. The VoIP network of claim 8, wherein the access switch further comprises:  
2           a line interface card terminating the access device and defining a subscriber interface for  
3 the access device;

4           a packet interface card connected to the IP backbone; and

5           a high bandwidth backplane commonly connecting the line interface card, the packet  
6 interface card, and IP backbone.

1 11. The VoIP network of claim 6, wherein the non-IP network comprises a Signaling  
2 System Seven (SS7) network and the signaling gateway further comprises:  
3 a SIP server element connected to the IP backbone; and  
4 a signaling gateway element translating SIP messages received from the IP backbone into  
5 SS7 messages, and translating SS7 messages received from the SS7 network into SIP messages.

1 12. The VoIP network of claim 6, wherein the non-IP network comprises a Signaling  
2 System Seven (SS7) network and the signaling gateway further comprises:  
3 a plurality of SIP server elements connected to the IP backbone; and  
4 a plurality of signaling gateway elements, each one of the plurality of signaling gateway  
5 elements being adapted to translate SIP messages received from the IP backbone into SS7  
6 messages, and to translate SS7 messages received from the SS7 network into SIP messages.

1 13. The VoIP network of claim 12, wherein respective SIP server elements and signaling  
2 gateway elements communicate one to another using SIP messages.

1 14. A method of bridging a call from an access device connected to a Voice over Internet  
2 Protocol (VoIP) network, the call being bridged to the Public Switched Telephone Network  
3 (PSTN) and the associated Signaling System Seven (SS7) network, the VoIP network comprising  
4 an access switch and a signaling gateway, and the method comprising the steps of:  
5 terminating the call in the access switch;  
6 maintaining all session state associated with the call in the access switch; and,  
7 maintaining only transaction state associated with the call in the signaling gateway.

1 15. The method of claim 14, wherein transaction state is maintained in the signaling  
2 gateway only during pendency of the related transaction.

1 16. The method of claim 15, further comprising:  
2 generating a Session Initiation Protocol (SIP) message in the access switch in response to  
3 an indication by the access device;  
4 transmitting the SIP message via the VoIP network to the signaling gateway; and,  
5 within the signaling gateway, directly translating the SIP message into an SS7 message  
6 and thereafter transmitting the SS7 message to the SS7 network.

1 17. A method of bridging a voice call from equipment connected to the Public Switched  
2 Telephone Network (PSTN) and the associated Signaling System Seven (SS7) network, to an  
3 access device connected to a Voice over Internet Protocol (VoIP) network, the VoIP network  
4 comprising a one or more access switches and a signaling gateway, and the method comprising  
5 the steps of:  
6 receiving in the signaling gateway an SS7 message transmitted from the SS7 network;  
7 directly translating the SS7 message into a Session Initiation Protocol (SIP) message;  
8 transmitting the SIP message from the signaling gateway to an access switch via the VoIP  
9 network;  
10 maintaining all session state associated with the call in at least one of the one or more  
11 access switches; and,  
12 maintaining only transaction state associated with the call in the signaling gateway.

1 18. The method of claim 17, wherein transaction state is maintained in the signaling  
2 gateway only during pendency of the related transaction.

1           19. A method of bridging a voice call from an access device connected to a Voice over  
2 Internet Protocol (VoIP) network, the call being bridged to the Public Switched Telephone  
3 Network (PSTN) and associated Signaling System Seven (SS7) network, the VoIP network  
4 comprising an access switch and a signaling gateway, wherein the VoIP network is connected to  
5 the PSTN via a Media Gateway Controller (MGC) and a Media Gateway (MG), the method  
6 comprising the steps of:

7           terminating the call in the access switch;  
8           maintaining all session state associated with the call in the access switch;  
9           maintaining no session state in the signaling gateway;  
10          without reference to the signaling gateway, transmitting a Session Initiation Protocol  
11 (SIP) INVITE message from the access switch to the MGC;  
12          upon receiving the INVITE message, setting up the call on the PSTN using an exchange  
13 of Media Gateway Control Protocol (MGCP) messages between the MGC and MG.

14           20. The method of claim 19, further comprising the steps of:  
15          following call setup, transmitting a 200 OK message from the MGC to the access switch;  
16          upon receipt of the 200 OK message, transmitting a ACK message from the access switch  
17 to the MGC; and thereafter,  
18          transmitting payload data from the access switch to the PSTN without reference to the  
19 signaling gateway.  
20

1           21. A method of establishing call setup in relation to a call between calling and called  
2 parties over a Voice over Internet Protocol (VoIP) network, the VoIP network comprising a  
3 signaling gateway, a first access switch directly connecting the calling party to the VoIP network,  
4 and a second access switch connecting the called party to the VoIP network through the Public  
5 Switched Telephone Network (PSTN) and associated Signaling System Seven (SS7) network,  
6 the method comprising the steps of:

7           terminating the call in the first access switch;

8           issuing a first Signaling Initiation Protocol (SIP) INVITE message from the first access  
9 switch to the second access switch, and maintaining session state associated with the call in at  
10 least one of the first and second access switches;

11           after receiving the first INVITE message, sending a second INVITE message from the  
12 second access switch to the signaling gateway;

13           maintaining transaction state associated with the call setup in the signaling gateway  
14 during only the pendency of the call setup transaction.

1           22. The method of claim 21, further comprising:

2           translating SIP messages received in the signaling gateway from the second access switch  
3 into SS7 messages and transmitting the SS7 messages to the PSTN, and

4           translating SS7 messages received in the signaling gateway from the PSTN into SIP  
5 messages and transmitting the SIP messages to the VoIP network.

1           23. The method of claim 22, wherein the step of translating SIP messages received in the  
2 signaling gateway from the second access switch into SS7 messages and transmitting the SS7  
3 messages to the PSTN further comprises:

4           forming an IAM message in the signaling gateway in response to the second INVITE  
5 message, and transmitting the IAM to the PSTN.

1           24. The method of claim 23, wherein the step of translating SS7 messages received in the  
2 signaling gateway from the PSTN into SIP messages and transmitting the SIP messages to the  
3 second access switch further comprises:

4           forming a first 200 OK message in the signaling gateway in response to ACM and ANM  
5 messages from the PSTN and transmitting the first 200 OK message to the second access switch;

6           transmitting a second 200 OK messages from the second access switch to the first access  
7 switch; and thereafter,

8           transmitting an ACK messages from the first access switch to the second access switch.

1           25. A method of invoking a call feature during a call from an access device connected to  
2 a Voice over Internet Protocol (VoIP) network, the VoIP network comprising an access switch  
3 connecting the access device and a signaling gateway, the VoIP network being connected to the  
4 Public Switched Telephone Network (PSTN) and associated Signaling System Seven (SS7)  
5 network, and the method comprising the steps of:

6           terminating the call in the access switch;

7           transmitting a first Signaling Initiation Protocol (SIP) INFO message from the access  
8 switch to the signaling gateway via the VoIP network;

9           translating the first SIP INFO message into an SS7 compatible INVOKE message;

10          transmitting the INVOKE message to a Service Control Point (SCP) via the SS7 network;

11          in response to the INVOKE message, transmitting an SS7 RESPONSE message from the  
12 SCP to the signaling gateway;

13          translating the RESPONSE message into a second SIP INFO message and transmitting  
14 the second SIP INFO message from the signaling gateway to the access switch via the VoIP  
15 network.

1           26. The method of claim 25, further comprising:

2           maintaining in the access switch all session state associated with the call; and,

3           maintaining no session state in the signaling gateway other than transaction state  
4 associated with the feature invocation.

1           27. The method of claim 26, wherein the signaling gateway maintains the transaction  
2 state associated with the feature invocation during only the pendency of the feature invocation  
3 transaction.

1           28. A signaling gateway adapted for use in a Voice over Internet Protocol (VoIP), the  
2 VoIP network being connected to the Public Switched Telephone Network (PSTN), and  
3 comprising a plurality of access switches and an IP backbone, wherein the signaling gateway  
4 comprises:

5           a first port receiving Session Initiation Protocol (SIP) messages from an access switch via  
6 the IP backbone;

7           a SIP parser/generator receiving SIP messages from the first port;

8           a second port receiving Signaling System Seven (SS7) messages from an SS7 network associated  
9 with the PSTN;

10          a SS7 protocol stack receiving SS7 messages from the second port;

11          a translator receiving SIP messages from the SIP parser/generator, directly translating the  
12 SIP messages into resulting SS7 messages, and transmitting the resulting SS7 messages to the  
13 SS7 protocol stack for subsequent transmission to the SS7 network;

14          wherein the translator also receives SS7 messages from the SS7 protocol stack, directly  
15 translates the SS7 messages into resulting SIP messages, and transmits the resulting SIP  
16 messages to the SIP parser/generator for subsequent transmission to the VoIP network.

1           29. The signaling gateway of claim 28, further comprising:

2           a memory maintaining transaction state associated with a SIP transaction message  
3 received from the VoIP network, wherein the transaction state is maintained in memory only  
4 during the pendency of the transaction.

1           30. The signaling gateway of claim 28, further comprising:

2           a memory maintaining transaction state associated with a SS7 transaction message  
3 received from the PSTN, wherein the transaction state is maintained in memory only during the  
4 pendency of the transaction.



1           31. A method of operating a signaling gateway in a Voice over Internet Protocol (VoIP)  
2 network connected to the Public Switched Telephone Network (PSTN) and an associated  
3 Signaling System Seven (SS7) network in response to a call, the method comprising:  
4           receiving a Session Initiation Protocol (SIP) transaction message from the VoIP network;  
5           directly translating the SIP transaction message into a resulting SS7 message;  
6           transmitting the resulting SS7 message to the SS7 network;  
7           storing no session state associated with the call in the signaling gateway other than  
8 transaction state associated with the transaction message, and storing the transaction state only  
9 during the pendency of the transaction.

1           32. The method of claim 31, wherein the step of directly translating the SIP transaction  
2 message into a resulting SS7 message comprises:  
3           directly mapping by type the SIP transaction message into the resulting SS7 message.

1           33. A method of operating a signaling gateway in a Voice over Internet Protocol (VoIP)  
2 network connected to the Public Switched Telephone Network (PSTN) and an associated  
3 Signaling System Seven (SS7) network in response to a call, the method comprising:  
4           receiving an SS7 transaction message from the PSTN network;  
5           directly translating the SS7 transaction message into a resulting Session Initiation  
6 Protocol (SIP) message;  
7           transmitting the resulting SIP message to an access switch in the VoIP network;  
8           storing no session state associated with the call in the signaling gateway, other than  
9 temporarily storing state associated with the transaction message during the pendency of the  
10 transaction.

1           34. The method of claim 33, further comprising:  
2           predefining the resulting SIP message in the signaling gateway by use of a generic  
3 transport message communicating the substance of the SS7 transaction message to the access  
4 switch.

1           35. A method of maintaining session state in a Voice over Internet Protocol (VoIP)  
2 network connected to the Public Switched Telephone Network (PSTN) and an associated  
3 Signaling System Seven (SS7) network, the VoIP network comprising a plurality of access  
4 switches and at least one signaling gateway, the method comprising:

5           terminating a call from an access device in a first access switch;  
6           determining a location identified by the call and identifying a second access switch  
7 associated with the location;  
8           maintaining all session state associated with the call in at least one of the first and second  
9 access switches during the call, but maintaining no session state in the signaling gateway other  
10 than transaction state associated with a transaction occurring during the call.

1           36. The method of claim 35, wherein the transaction state is maintained in the signaling  
2 gateway only during pendency of the related transaction.

1           37. A method of operating a signaling gateway in a Voice over Internet Protocol (VoIP)  
2 network connected to the Public Switched Telephone Network (PSTN) and an associated  
3 Signaling System Seven (SS7) network in response to a call, the method comprising:

4           receiving in the signaling gateway a SS7 message from the PSTN, the message being  
5 associated with an exception condition or communication error;

6           translating the SS7 message into a resulting Session Initiation Protocol (SIP) message;  
7 and,

8           statelessly transmitting the resulting SIP message to an access switch in the VoIP  
9 network.